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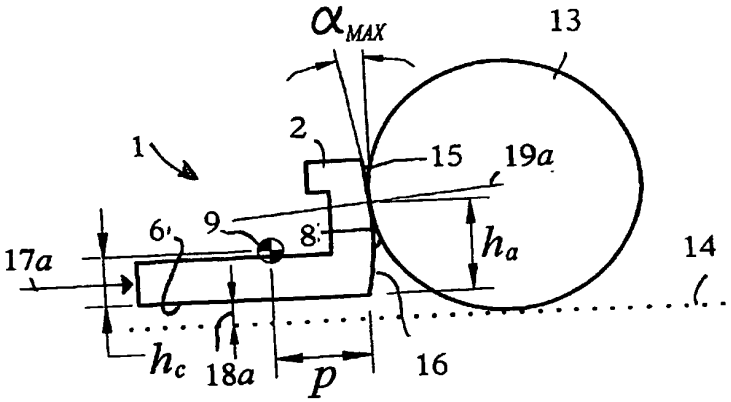
(54) Title: PUTTER HEADS



(57) Abstract: A putter-head (1) giving positive ball-topspin (S) for impact-heights (h_i) above 5 mm from its sole (6), has its centre of mass (9) located p mm behind its impact face (8) at height $h_c$mm above the sole (6), a mass M kgm and a radius of gyration K mm about the heel-toe axis (4-5) through the centre of mass (9). The loft (α) of the impact face (8) increases monotonically with height from 5 to 15 mm above the sole (6), where (K^2/p) is greater than 5 mm and $S = S_G + s_L$ where S_G and S_L are percentage spin rates based on: $S_G = (250 \times h) / [(3.2 + 70 \times M) \times (K2/p) + p]$; $S_L = (-0.76 \times \alpha_i) / [1 + 0.04 \times (p/K)^2]$ *for which:* $h = h_i - h_c - p \times \sin(\alpha_i)$ and α_i degrees is impact-face loft at height h_i. From the sole (6) upwards, the impact face curves (16) from negative- to positive-loft and merges into an upper flat-portion (15) of positive loft. Alternatively, it has upper and lower flat-portions (21, 22) of positiveand negative-loft respectively. A hosel (30, 31) gives high compliance at impact for head-rotation relative to the shaft (33) about the heel-toe axis (4-5), and allows choice of lie in shaft-attachment.

WO 2004/035149 A1

Putter-Heads

This invention relates to putter-heads and is concerned especially with putter-heads for imparting topspin to a golf ball at impact.

In putting a golf ball, it is desirable to impart forward rolling spin or topspin to the ball during the putting stroke. Topspin reduces ball skid on the putting surface and helps to initiate pure rolling motion. Imparted topspin is defined as the component of ball spin about a horizontal axis parallel to the putter impact-face imparted at impact by a putter such that the ball peripheral speed on the top surface of the ball exceeds its linear or translational speed.

It is known that putters with negative face-loft normally hit above the horizontal equator of a golf ball and thus tend to impart topspin. However, this type of impact disadvantageously forces the ball downwards and into the putting surface, causing erratic loss of launch energy, especially on soft putting greens.

Thus, it is preferable that the impact point on the ball is below its equator, which generally ensures that the ball lifts off the putting surface at impact. Impacts just above the horizontal equator of the ball are also acceptable, especially if combined with an upward putter-head trajectory as this ensures that the downward component of impact force is a small fraction of the total and so has negligible deleterious effect on the putt.

It is one of the objects of the present invention to provide an improved putter-head for imparting topspin to a golf ball at impact.

According to the present invention there is provided a putter-head for imparting a positive rate (S) of topspin on a golf ball for impacts with the ball throughout a range of impact height (h_i) extending above 5 millimetre from the bottom of the putter-head, wherein the head has a centre of mass located at a distance p millimetre behind its impact face and a height h_c millimetre above the bottom of the head, a mass M kilogram and a radius of gyration K millimetre about the heel-toe axis through the centre of mass, and the loft (α) of the impact face increases monotonically with height from 5 to 15 millimetre above the bottom of the putter-head, and wherein:

(a) $$K^2/p > 5$$

and

(b) $$S = S_G + S_L$$

where the spin rates S_G and S_L expressed as percentages, are as follows:

$$S_G = (250 \times h) / [(3.2 + 70 \times M) \times (K^2/p) + p]$$

$$S_L = (-0.76 \times \alpha_i) / [1 + 0.04 \times (p/K)^2]$$

for which:

$$h = h_i - h_c - p \times \sin(\alpha_i)$$

and

α_i degrees is the impact-face loft at height h_i millimetre.

The loft (α_{15}) at 15 millimetre above the bottom of the head may be at least 3 degrees larger than the loft (α_5) at 5 millimetre above the bottom of the head, but is preferably at least 5 degrees or more especially, 7 degrees, larger.

The minimum value of rate *S of* topspin may be at least +2.5% or, more preferably, +5.0% for values of h_t above 5 millimetre from the bottom of the putter-head. For values of h_t down to 2.5 millimetre, the minimum spin rate *S* is preferably +5.0%. For preference, the height h_c may be less than 10 millimetre, or, more preferably, not more than 7 millimetre, and the value of (K^2/p) may for preference be not less than 5 or, more especially, 8 millimetre. The distance *p* is preferably at least 10 millimetre and less than 35 millimetre but more preferably less than 30 millimetre.

For preference a putter-head according to the invention is provided with shaft attachment means that provides additional compliance to rotation of the head of up to ±0.5 degrees relative to the shaft to enable achievement of vertical gear effect. Head rotation about the heel-toe axis may also be increased by arranging that stiffness of the shaft where it attaches to the putter-head is minimised. This is achieved by ensuring that the shaft deformation during impact is predominately in bending or twisting mode rather than in axial compression or elongation mode. Thus for preference, a putter-head according to the invention may be provided with shaft attachment means wherein the axis of the shaft-attachment means is horizontally displaced *d* millimetre either side of the horizontal heel-toe axis through the centre of mass. To optimise the imparted topspin properties of the assembled putter, *d* should be ideally zero or less than *r*, where *r* is the radius of the putter shaft at the shaft-attachment means. It is also advantageous for the

horizontal displacement (measured in any direction) of the shaft-attachment means from the centre of mass of the putter-head to be less than the radius of gyration *K*.

Putter-heads in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 to 3 are front-elevation, rear-elevation and plan view respectively of a first putter-head according to the invention;

Figure 4 is a sectional side-elevation of the first putter-head taken on the line IV-IV of Figure 3;

Figure 5 is a perspective view from the rear of the first putter-head;

Figures 6a and 6b are, respectively, diagrammatic views of the centre section of the first putter-head and a golf ball at impact, in two different circumstances;

Figure 7 is a sectional side-elevation of a second putter-head according to the invention;

Figure 8 is illustrative of a form of hosel that may be used in the putter-heads of Figures 1 to 5 and Figure 7;

Figures 9a and 9b are, respectively, sectional views of use of the hosel of Figure 8 in providing two different angles of lie of the putter-shaft; and

Figure 10 is in further illustration of a feature of the hosel of Figure 8.

Referring to Figures 1 to 5, the putter-head 1, comprises an impact-face flange 2 and a base 3. The base 3, which

forms the major part of the putter-head 1, defines the heel 4, the toe 5 and the sole 6 of the head 1, and incorporates a shaft-hosel 7. The flange 2 is of an unusually thin section for a putter-head, being for example of 4 millimetre or less in thickness, yet establishes a rigid interface between the impact face 8 and the base 3. This rigidity is important in ensuring that impacts on the middle or upper part of the face 8 do not deflect the flange 2 relative to the base 3, but instead rotate the entire head 1 fully about its centre of mass 9. This in turn ensures that the putter-head 1 behaves as a rigid body during impact, and parameters such as imparted ball spin and velocity are accurately predictable and fully achieved.

In one construction of the putter-head 1 of Figures 1 to 5, the desired rigidity and mass properties are realised by casting it of 316 stainless steel or a similar alloy. In an alternative construction, the impact flange 2 is provided as a separate part of titanium, aluminium or magnesium alloy or of a high modulus composite. The main requirement is that the flange 2 has a mass which is a small proportion of the overall mass of the putter-head 1, yet provides a rigid interface between the golf ball and the base 3 at impact. This allows the centre of mass 9 to be positioned close to the bottom surface or sole 6, and some distance from the face 8. The height h_c of centre of mass 9 above the sole 6 is preferably less than 10 millimetre or, more preferably, not more than 7 millimetre since this limits the amount of negative loft required.

A very high value of p, the distance of centre of mass 9 behind the impact face 8, produces high sidespin and directional errors under offset impacts. This undesirable characteristic can be reduced by increasing the moment of inertia of the head 1 about the vertical

axis, but increase of this moment affects playing control and/or requires the mass of the head 1 to be excessive. As a result, it is preferable to limit the distance p to be less than 35 millimetre, but, more preferably, less than 30 millimetre. Small values of p are disadvantageous in putter-heads of the present invention since they severely limit vertical gear effect, and accordingly, it is preferred to adopt a construction for which p is at least 10 millimetre.

By way of modification of the putter-head of Figures 1 to 5, the impact face 8 may be formed by material which is softer than that of the flange 2 and which is provided as a layer, or as an insert, bonded to the flange 2 for reducing vibration and noise intensity (so as to give a so-called 'soft-feel'). However, it is disadvantageous to have the entire structure of the flange 2 in soft material as this reduces topspin imparted by vertical gear-effect.

The putter-head of Figures 1 to 5 and its action will now be described in further detail with reference to Figures 6a and 6b which are, respectively, diagrammatic representations of the centre section of the putter-head 1 at the instant of impact with a golf ball 13 resting on a putting surface 14, in two different circumstances.

As illustrated in exaggerated form in Figures 6a and 6b, the impact face 8 of the putter-head 1 is of curved profile transversely of the heel-toe axis only, and has a lower, curved half 15 that has a loft angle α degrees which increases with increase in height, progressively from a negative value at the sole 6, through zero to a positive value α_{MAX} where it merges into the upper half 16 of the face 8. The upper half 16 is flat and has a loft angle of α_{MAX} so as to be tangential to the lower half 15 where they merge; accordingly, the loft of the impact

face 8 increases monotonically throughout its full height upwardly from the sole 6.

As represented only in Figure 6a, the centre of mass 9 of the putter-head 1 is located at distance p millimetre behind the impact face 8 and at a height h_c millimetre above the sole 6. The centre of impact of the face 8 with the ball 13 (which is a playing variable with random error) is shown as occurring at height h_a above the sole 6 in the circumstances of Figure 6a but at height h_b in the circumstances of Figure 6b.

The main effect required of the impact is to launch the golf ball 13 with linear velocity substantially along the intended line of putt and preferably with a slight positive (upward) elevation angle. The upward trajectory is often provided by a small amount of loft (typically +3 degrees) on the impact-face of a putter. Moreover, most golfers adopt an approximate 'pendulum swing' in putting, in which the putter-head is swung about a substantially horizontal axis with the swing rotation axis and the putter shaft axis in (or nearly so) a common plane that is substantially parallel to the heel-toe axis of the putter-head. The main variable with this type of swing is the position of the ball in relation to the vertical arc followed by the putter-head. For preference, impact with the ball occurs at or just beyond the bottom of the arc (on the upward part of the arc), but in practice may occur before or later than this.

In the circumstances represented in Figure 6a, impact takes place at the bottom of the arc, where the putter-head trajectory is horizontal (shown by arrow 17a). Impact in such circumstances generally occurs at mid-height, within the upper part 15 of the impact face 8. The loft angle α_{MAX} applies provided the clearance 18a between the putting surface 14 and the sole 6 is not more

than the radius of the ball 13 less the height of the curved lower half 16 of the impact face 8. If the ground-to-sole clearance 18a is more than this, the height of contact will increase and may disadvantageously rise above the horizontal equator of the ball 13 and consequently launch the ball 13 with a slight negative elevation trajectory. This type of putting stroke is rare except with players of less than moderate skill and typifies poor putter control. Nevertheless it is preferred that excessive negative ball trajectory is avoided by providing that the region on the impact-face where the loft is negative is limited to the lower 12 millimetre, or more preferably the lower 9 millimetre.

Figure 6b represents the circumstances in which impact occurs at a point beyond the bottom of the pendulum arc where the putter-head trajectory (depicted by arrow 17b) has positive elevation. The ball launch trajectory in these circumstances is dependent on the combination of trajectory elevation angle and the loft angle at impact; the latter is generally slightly negative and varies both with the ground clearance 18b and the elevation angle of the trajectory 17b. Provided the sum of putter-head trajectory angle and loft angle at impact point is greater than -20% of the trajectory elevation angle, the ball launch elevation angle will be positive. Thus, the ball is still given a slight lift for impacts in the lower (negative loft) region of the impact-face 8 provided the bottom of the pendulum arc is kept low as before.

The aim of the present invention is to provide a putter-head that imparts topspin on the ball from all pendulum-swing putts but also provides high probability of imparting positive lift on the ball at impact.

It is known that two mechanisms impart spin with club-on-ball impact in golf, namely eccentric impact, commonly known as 'gear-effect', and oblique impact which is most commonly experienced as backspin due to club-face loft. The gear-effect realised with a putter-head is dependent on the condition that the line of impact (that is, the line normal to the impact surfaces at the point of impact) is offset from the centre of mass of the head. It follows that the condition for gear-effect with the putter-head of the present invention is also dependent on the loft angle of the impact face at the point of impact.

The offset distance h between the line of impact and the centre of mass 9 is given by:

$$h = h_i - h_c - p \times \sin(\alpha_i) \quad \ldots(1)$$

where h_c and h_i are, respectively, the height (millimetre) of the centre of mass 9 and the impact point above the bottom-most part, the sole 6, of the putter-head, and α_i (degrees) is the loft angle of the putter face 8 at the point of impact (positive for upward tilt).

The value of spin attainable with gear-effect is known from Newtonian dynamics assuming that the putter-head and golf ball behave as free rigid bodies at impact, and is given, as a percentage, by:

$$S_G = (250 \times h) \,/\, [(3.2 + 70 \times M) \times (K^2/p) + p] \quad \ldots(2)$$

where M is the putter-head mass (kilogram), K is the radius of gyration for rotation about the horizontal heel-toe axis through the centre of mass (millimetre) and S_G is the ratio (expressed as a percentage) of the peripheral velocity of the ball due to rotation, to its linear or translational velocity.

It is found that S_G is highly dependent on the term (K^2/p) in equation (2). A low value of this term, such as 5 (millimetre) gives a very high vertical gear effect, which in turn requires high negative loft to overcome the tendency for backspin at low impact heights. It is also the case that most conventional putter-heads (especially low cost, one-piece cast heads) have values of (K^2/p) of 10 to 20 or so, and golfers are familiar and more attuned to this weight distribution. It is thus an aim with the putter-head of the invention to arrange that (K^2/p) is at least more than 5 millimetre, but preferably 8 millimetres or more.

Further, golfers are not used to putters having very low inertia about the heel-toe axis (or about any other axis). Such low-inertia putters can feel less 'solid' to play with, which is disadvantageous. It is accordingly preferable that the value of the heel-toe inertia, namely, $(M \times K^2)$, is not less than 25 kilogram-millimetres^2 or, more preferably, is greater than 30 kilogram-millimetres^2.

For vertical gear effect to impart topspin rather than backspin, the value of h must be positive. This is exemplified in Figure 6a where the line of impact 19a (collinear with the centre of the ball 13 and the impact point) passes above the centre of mass 9.

With pendulum-swing putts the putter-head elevation trajectory is always parallel to the sole 6 and therefore the spin imparted due to oblique impact is a function of the impact-face loft α_l but not trajectory, and is given by:

$$S_L = (-0.76 \times \alpha_l) \; / \; [1 + 0.04 \times (p/K)^2] \qquad \ldots(3)$$

where S_L denotes the spin ratio (expressed as a percentage and defined as for S_G) as a function of loft. It is to be noted that positive loft imparts negative spin or backspin and negative loft imparts topspin.

Conveniently, it is practical to provide negative loft, which in turn imparts topspin, in the lower half 16 of the impact-face 8 and this compensates for the fact that the height h defined in equation (1) normally becomes negative for small values of h_i. This is depicted in Figure 6b where the line of impact 19b is shown to pass below the centre of mass 9.

The value of height h can in practice be kept positive even for zero impact-height h_i by arranging that:

$$h_c - p \times \sin(\alpha_i)$$

remains positive. However, this option requires severely negative loft, especially for smaller values of distance p and thus undesirably imparts negative ball-launch trajectory rather than the desired lift. It is thus much more preferable to arrange that the sum of S_L and S_G is positive at least for putts above the lower limit of useful impact height, for example above 5 millimetres or 2.5 millimetres. It is preferable that the minimum spin rate is +2.5%, or more preferably +5.0%, above 5 millimetres, but below this down to 2.5 millimetres, it is very desirably +5.0%.

Since the diameter of the impact footprint (that is, the contact deformation area) is usually at least 5 millimetres (except for very low-velocity putts), impacts at heights below 2.5 millimetres encroach onto the lower lip of the impact face. In these circumstances, an impact will 'top' the ball, giving abundant topspin but at the expense of erratic length and direction control.

It can be seen from equations (1) to (3) that a number of putter-head parameters determine spin rate, namely p, h_c, M, K and α_i (which is a function of impact height). Typical value ranges of these parameters for blade-style putters according to the invention, are given in Table I.

Table I

p	10 to 18 millimetres
h_c	6 to 10 millimetres
M	0.31 to 0.36 kilogram
K	10 to 13 millimetres

For mallet-style putters the values for distance p and radius of gyration K are generally larger than those for blade-style putters. Table II below gives an example of a putter-head based on Figures 1 to 5.

Table II

p = 16 millimetres
h_c = 6.8 millimetres
M = 0.32 kilogram
K = 11.6 millimetres
α_{MAX} = 2.0 degrees (h_i > 12 millimetres)

h_i (mm)	α_i (deg)	S_G (%)	S_L (%)	$S_G + S_L$ (%)
2.5	-7.5	-2.4	+5.3	+2.9
5	-5.0	-0.5	+3.5	+3.0
12	+2.0	4.9	-1.4	+3.5

It is found in practice that the position of the shaft hosel 7 has a strong influence on the putter-head rotation about the heel-toe axis during the very short duration of impact (less than one millisecond). It has been found experimentally that if distance *d* is the horizontal offset between the shaft attachment axis and the heel-toe axis, topspin performance is enhanced when *d* is zero and that increasing *d* reduces the imparted topspin. In order to optimise the imparted topspin properties of the assembled putter, *d* should be ideally zero, or, more generally, less than the radius *r* of the putter-shaft.

A further advantage of positioning the shaft coupling close to the centre of mass of the putter-head is that shaft vibrations due to eccentric impact are minimised. In this respect, it is advantageous that the axis of the means for attachment of the shaft passes close (preferably not more than *K* millimetres) to the centre of mass of the putter-head (as distinct from the heel-toe axis through this centre).

Figure 7 shows a sectional side-elevation of a putter-head 20 that is generally the same as the putter-head of Figures 1 to 5 except that the impact face in this case comprises an upper, flat-face portion 21 and a lower, flat-face portion 22. The upper portion 21 has typically zero or positive loft whereas the lower portion 22 has negative loft; differences in loft are exaggerated in Figure 7. The upper and lower portions 21 and 22 join one another in a horizontal junction 23 (which is parallel to the heel-toe axis and thus normal to the plane of Figure 7). The loft angle of the impact face accordingly changes abruptly at the junction 23, but the effective loft actually experienced for impacts on or near the junction 23 changes only gradually as the point of impact is moved through the junction 23, owing to the

softness of the cover material of the ball. More particularly, the softness results in the impact force being distributed above and below the junction 23 with the result that the effective loft tends to a value intermediate the lofts of the two flat-face portions 21 and 22; the junction 23 can be chamfered or rounded to enhance the distribution. The change in loft may also be made more gradual by reducing the hardness of the impact surface, for example by using an elastomer insert instead of a steel face as depicted in Figure 7.

Figure 8 shows a sectional view of an alternative form of hosel involving a male stub 30 and an annular recess 31 concentric with it. The axis 32 of stub 30 is inclined at the desired lie angle relative to the horizontal for attachment of the putter-shaft. Attachment of the shaft is carried out by applying a thixotropic adhesive within the hollow tip of the shaft and then placing the shaft-tip over the stub 30 to locate within the surrounding annular recess 31; the adhesive desirably has good gap-filling properties and may, for example, be the 'E3332' epoxy adhesive sold under the registered trade mark PERMABOND. The recess 31 is typically only 2 to 3 millimètres deep and serves to centre the shaft-tip relative to the stub 30.

The dimensions of the stub 30 and recess 31 are such that the shaft can be fitted at different angles relative to the concentric position so as to allow for different lie preferences. This is illustrated by Figures 9a and 9b, Figure 9a showing adoption of an 'upright' lie for shaft 33 on the stub 30 in which the shaft 33 is inclined at an angle of 78 degrees to the horizontal. Figure 9b on the other hand, shows adoption of a 'flat' lie in which the shaft 33 is inclined at an angle of 66 degrees to the horizontal.

Referring again to Figure 8, the seating plane at the bottom of the annular recess 31 is shown by dashed line 34, and intentionally not square to the axis 32 but is instead tilted towards the horizontal so that the tip of the shaft 33 rests on nominally one point on the plane containing line 34. This arrangement is shown more clearly in Figure 10 where the tip of shaft 33 touches line 34 at only one point 35. It is arranged that this point 35 is located on the heel-toe axis 36.

At impact, the putter-head rotates about the heel-toe axis 36. This arrangement provides very high compliance to putter-head rotation relative to the shaft 33 about the heel-toe axis 36 since the rim of the shaft 33 is decoupled from the putter-head body via the cured adhesive material of relatively low modulus, and the only direct contact with the putter-head is at the one point 35 on the axis 34 of rotation.

Claims:

1. A putter-head for imparting a positive rate (S) of topspin on a golf ball for impacts with the ball throughout a range of impact height (h_i) extending above 5 millimetre from the bottom of the putter-head, wherein the head has a centre of mass located at a distance p millimetre behind its impact face and a height h_c millimetre above the bottom of the head, a mass M kilogram and a radius of gyration K millimetre about the heel-toe axis through the centre of mass, and the loft (α) of the impact face increases monotonically with height from 5 to 15 millimetre above the bottom of the putter-head, and wherein:

(a) $$K^2/p > 5$$

and

(b) $$S = S_G + S_L$$

where the spin rates S_G and S_L expressed as percentages, are as follows:

$$S_G = (250 \times h) / [(3.2 + 70 \times M) \times (K^2/p) + p]$$

$$S_L = (-0.76 \times \alpha_i) / [1 + 0.04 \times (p/K)^2]$$

for which:

$$h = h_i - h_c - p \times \sin(\alpha_i)$$

and

α_i degrees is the impact-face loft at height h_i millimetre.

2. A putter-head according to Claim 1 wherein the loft (α_{15}) at 15 millimetre above the bottom of the head is at least 3 degrees larger than the loft (α_5) at 5 millimetre above the bottom of the head.

3. A putter-head according to Claim 2 wherein α_{15} is at least 5 degrees larger than α_5.

4. A putter-head according to Claim 3 wherein α_{15} is at least 7 degrees larger than α_5.

5. A putter-head according to any one of Claims 1 to 4 wherein S is at least +2.5%.

6. A putter-head according to Claim 5 wherein S is at least +5.0%.

7. A putter-head according to any one of Claims 1 to 6 wherein the head also imparts a positive rate (S) of topspin of at least 5.0% for impacts with the ball throughout a range of impact height (h_i) extending above 2.5 millimetre from the bottom of the putter-head.

8. A putter-head according to any one of Claims 1 to 7 wherein h_c is less than 10 millimetre.

9. A putter-head according to Claim 8 wherein h_c is not more than 7 millimetre.

10. A putter-head according to any one of Claims 1 to 9 wherein the ratio K^2/p is more than 5 millimetre.

11. A putter-head according to Claim 10 wherein the ratio K^2/p is not less than 8 millimetre.

12. A putter-head according to any one of Claims 1 to 11 wherein p is at least 10 millimetre.

13. A putter-head according to Claim 12 wherein p is less than 35 millimetre.

14. A putter-head according to Claim 13 wherein p is less than 30 millimetre.

15. A putter-head according to any one of Claims 1 to 14 including shaft-attachment means and wherein a putter-shaft is attached to the head via the shaft-attachment means and the horizontal offset of the axis of the shaft from the heel-toe axis is less than the radius of the shaft at the shaft-attachment means.

16. A putter-head according to Claim 15 wherein the shaft-attachment means has zero horizontal offset from the heel-toe axis.

17. A putter-head according to Claim 15 or Claim 16 wherein the horizontal displacement of the shaft-attachment means from the centre of mass is less than the radius of gyration K.

18. A putter-head according to any one Claims 1 to 17 wherein the impact face includes an upper, flat portion having positive loft.

19. A putter-head according to any one of Claims 1 to 18 wherein the impact face includes a lower portion which is curved and has loft that increases from a negative value to a positive value upwardly from the bottom of the head.

20. A putter-head according to any one Claims 1 to 18 wherein the impact face includes a lower, flat portion having negative loft.

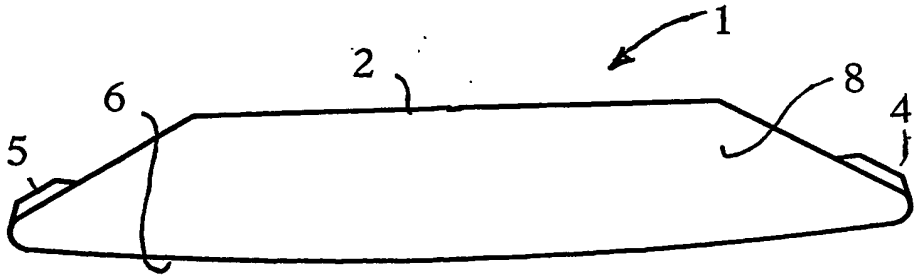


Fig.1

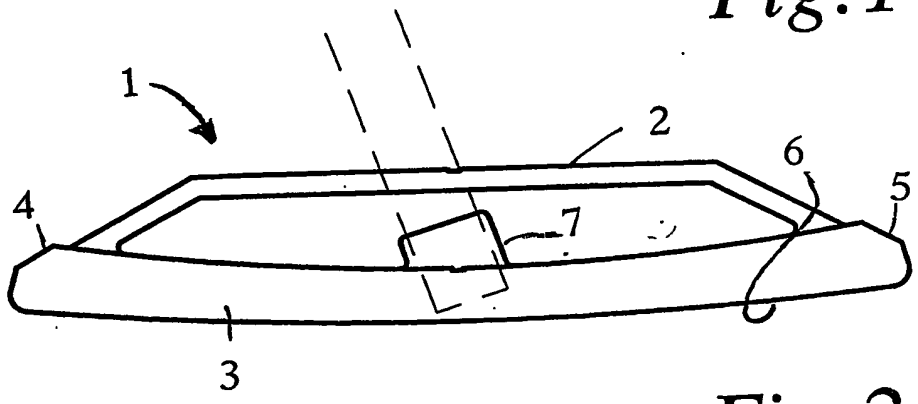


Fig.2

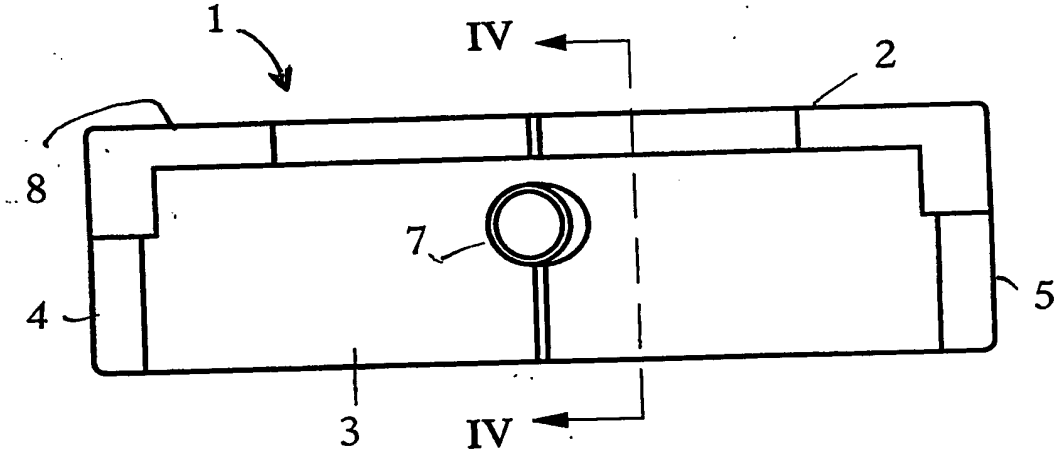


Fig.3

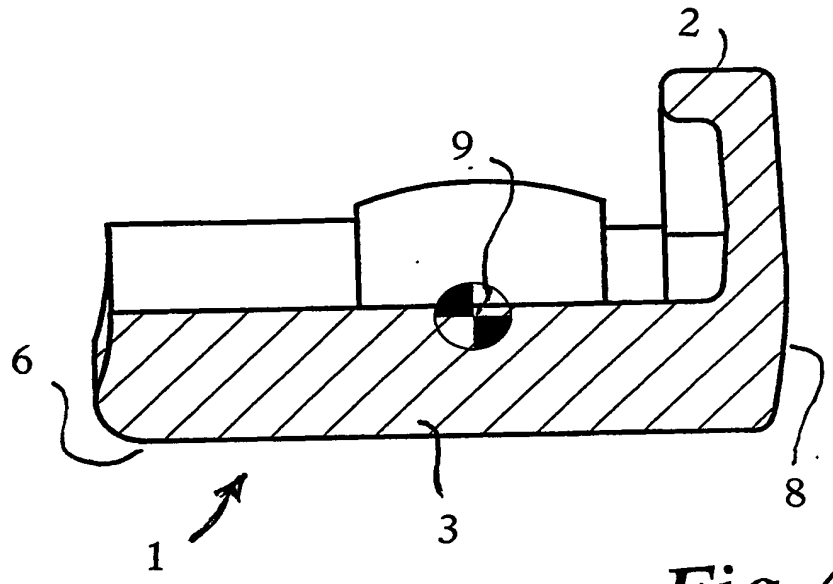


Fig.4

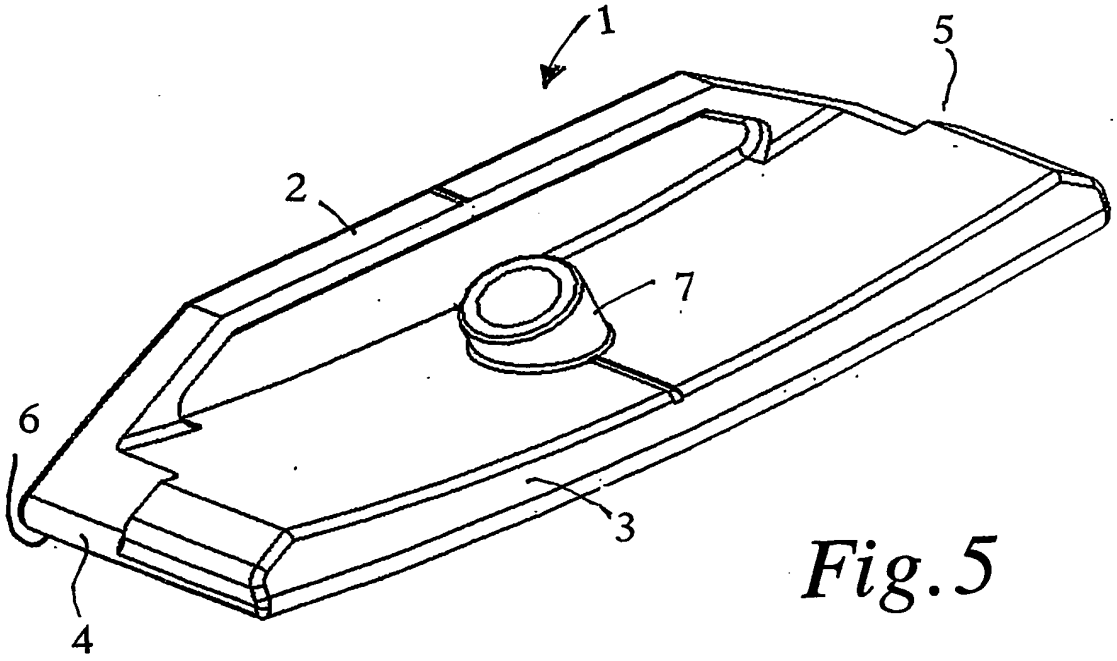


Fig.5

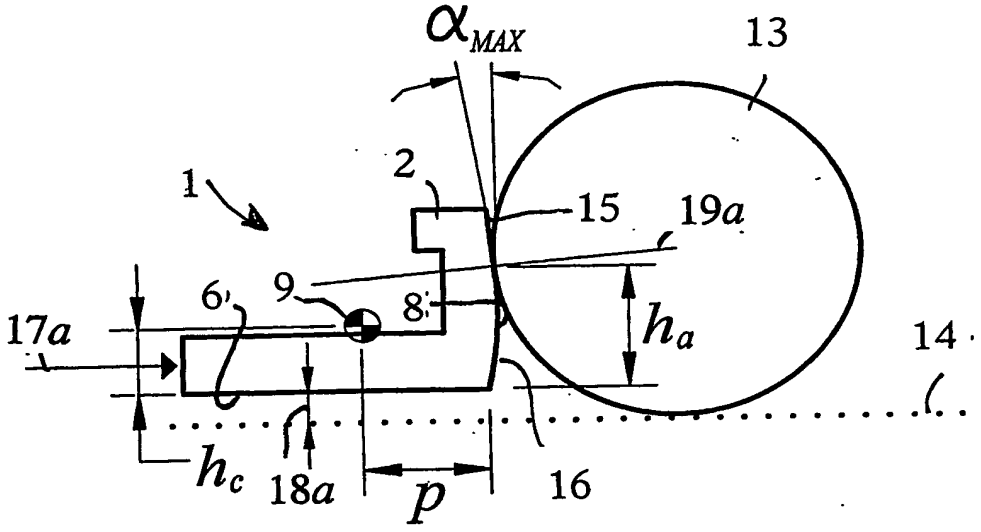

α_{MAX}
13
2
1
15
19a
6
9
8
17a
h_a
14
h_c
18a
p
16

Fig. 6a

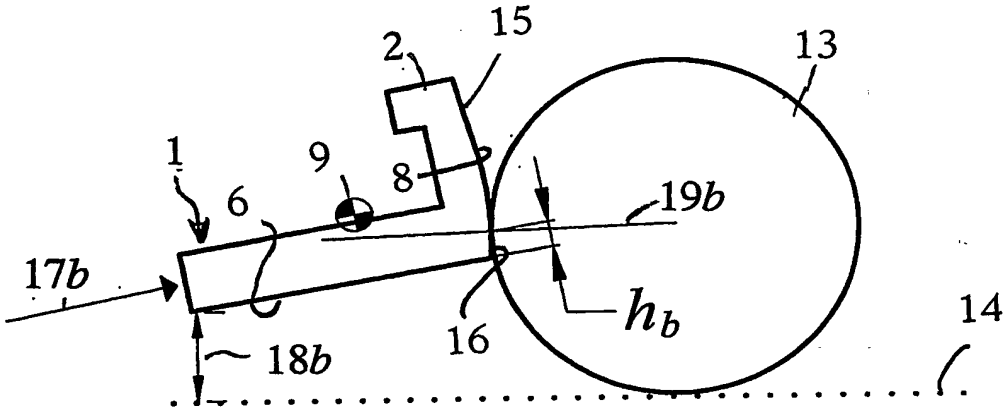

15
2
13
1
9
8
6
19b
17b
h_b
14
16
18b

Fig. 6b

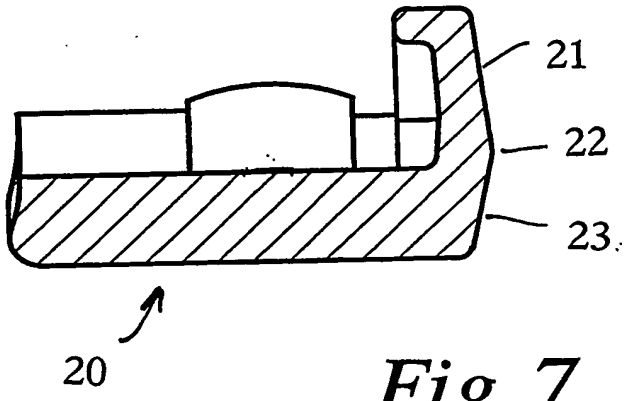


Fig. 7

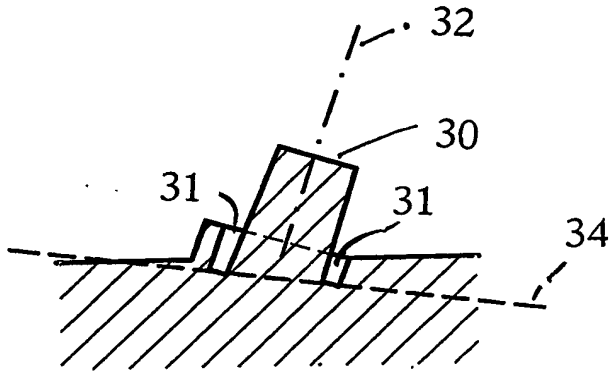


Fig. 8

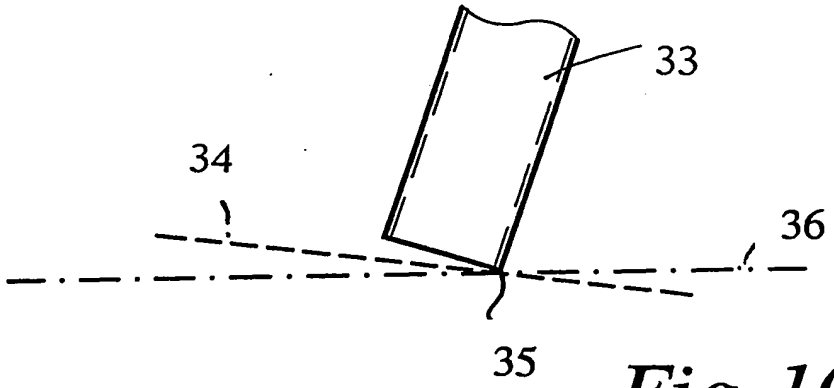


Fig. 10

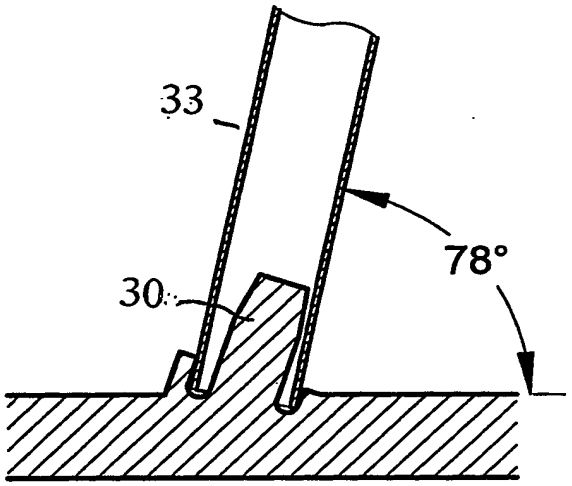


Fig. 9a

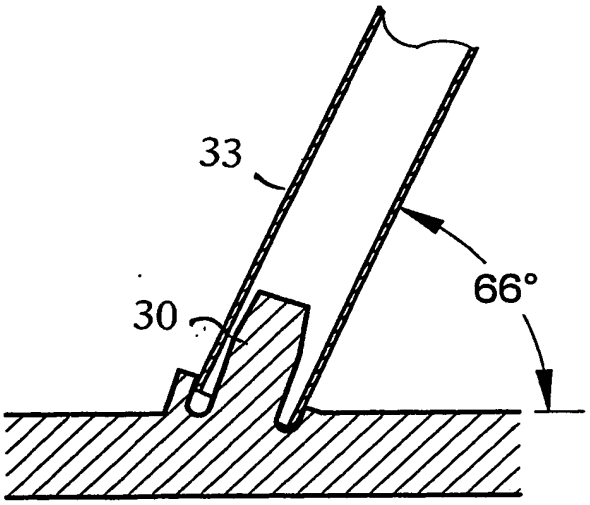


Fig. 9b

INTERNATIONAL SEARCH REPORT

Inter[illegible]pplication No
PC[illegible]B 03/04543

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A63B53/04 A63B53/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 03/020372 A (LINDSAY NORMAN MATHESON) 13 March 2003 (2003-03-13) the whole document	1-4,8-20
X	US 5 303 923 A (GARCIA LARRY) 19 April 1994 (1994-04-19) column 1, line 60 - column 2, line 22; figures	1-4, 18-20
X	WO 99/24124 A (TEARDROP GOLF COMPANY ;ZERAVICA JOHN (US); REED TIMOTHY R (US); SL) 20 May 1999 (1999-05-20) page 5, paragraph 2 - page 6, paragraph 4; figures	1
X	US 1 525 137 A (LAWTON CHARLES L) 3 February 1925 (1925-02-03) the whole document	1

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 February 2004	27/02/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Squeri, M

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 095 931 A (HALL J NEIL ET AL) 1 August 2000 (2000-08-01)	
A	GB 2 213 390 A (CANMORE GOLF MANUFACTURING COM) 16 August 1989 (1989-08-16)	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 03/04543

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 5-7 (not searched), 8-20 (searched partially)
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 5-7 (not searched), 8-20 (searched partially)

Present claims 5-7 relate to a putter head defined (inter alia) by reference to the following parameters:

S=SG+SL

SG=(250Xh)/'(3.2+70XM)x(K 2/P)+P!

SL=(-0.76xai)/'1+0.04x(P/K) 2!

S, SG and SL are defined in claim 1, but they do not actually limit the subject-matter of claim 1 because no values are given for them in claim 1. Claims 5-7, however, introduce some limiting values for S and could not be searched. Claims 8-20 have been searched only in combination with claims 1-4, they have non been searched as dependent from claims 5-7.

The use of these parameters in the present context is considered to lead to a lack of clarity within the meaning of Article 6 PCT. It is impossible to compare the parameters the applicant has chosen to employ with what is set out in the prior art. The lack of clarity is such as to render a meaningful complete search impossible. Consequently, the search has been restricted to: claims 1-4 and 8-20 (partially).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

[redacted]mation on patent family members

Inter[redacted]pplication No
PC[redacted]B 03/04543

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			NZ	513145 A	25-10-2002
			WO	0038797 A1	06-07-2000
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